SPAWAR Systems Center San Diego

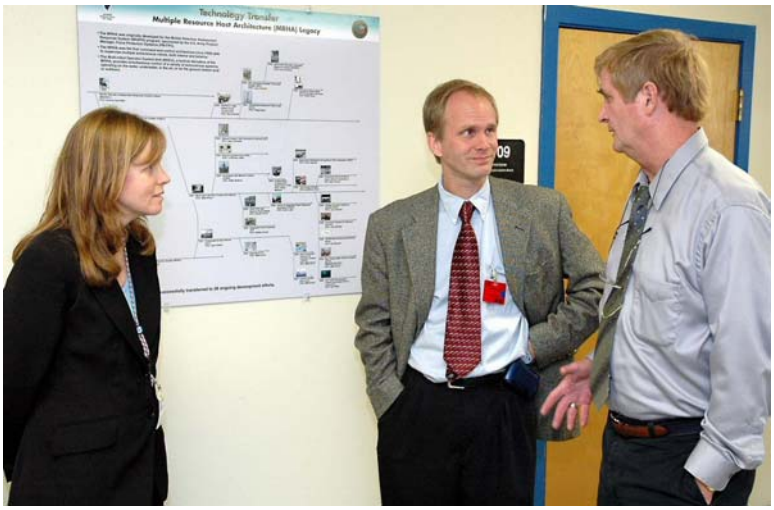
Space and Naval Warfare Systems Center, San Diego (SSC San Diego)

ROBOTICS UPDATE

"Providing network-integrated robotic solutions for C4ISR applications."

www.spawar.navy.mil/robots/ Fall 2005 / Vol. 5, No. 3

Center Conducts Collaborative UGV/UAV/USV Demonstration



Kathy Mullens (left) and Bart Everett (right) discuss with Dave Thomas (center) the wall poster depicting various projects that have adopted the Multi-robot Operator Control Unit (MOCU).

On 13 and 15 December, in conjunction with the Unmanned Systems Capabilities Conference II, SSC San Diego performed a series of collaborative behavior demonstrations involving multiple unmanned autonomous systems in a force-protection scenario. These demonstrations included simultaneous control of an unmanned surface vehicle (USV), an unmanned ground vehicle (UGV), and an unmanned aerial vehicle (UAV) using the Multi-robot Operator Control Unit (MOCU) command and control software. MOCU was designed to control multiple robots/sensors across various domains (i.e., air, land and sea). Its modular architecture scales to any vehicle's requirements (i.e., map, communications protocol, mission planner) and human-interface needs (i.e., gauges, map windows, video inputs). All three unmanned systems communicated with MOCU using the Joint Architecture for Unmanned Systems (JAUS) protocol.

Would-be "intruders" William Morgart and Narek Pezeshkian attempt to penetrate the defensive perimeter.

Several other technologies were also showcased, including the Mobile Detection Assessment Response System Exterior (MDARS-E) security robot, the Multiple Resource Host Architecture (MRHA), simultaneous localization and mapping (SLAM), human-presence detection, automated UAV refueling, remotely operated weapons, and unattended ground, video, and radar sensors.

In the simulated threat scenario, an unknown group of amphibious commandos landed on the beach and infiltrated inland, presumably intending to crest the hill and attack the submarine base. Pre-positioned radar and vibration sensors detected the incursion and alarmed in the Robotic Operations Command Center (ROCC). Triggered by unattended ground sensors, the Man-portable Perimeter Protection (MPP) system automatically provided confirming video of two armed intruders heading east.

The MDARS-E vehicle (equipped with an automatic weapon and a UGV marsupial carrier) was dispatched south from the ROCC to intercept the threat on Woodward Road. A second MDARS-E vehicle with an intrusion detection payload was also dispatched to provide backup. The USV, already patrolling off the coast, was redirected south by the MOCU operator to assess from the sea. With onboard collision-avoidance and path planning capabilities, the USV was able to reroute itself to provide video surveillance of other possible hostile forces in the area.

The autonomous RotoMotion helicopter executes GPS waypoint navigation enroute to the underground bunker.

The MDARS vehicles detected no sign of troop movement on the ground, indicat-

Mike Bruch provides attendees a step-by-step narration of MOCU operations during the collaborative behavior demonstrations on 13 and 15 December.

Collaborative UGV/UAV/USV Demonstration *(continued)*

ing that possible refuge had been taken in an underground WW-II bunker. Accordingly, MOCU launched the autonomous helicopter (UAV) to obtain low-altitude mission-planning imagery and realtime reconnaissance of the incursion area. Executing GPS waypoint navigation, the helicopter entered a low-level (100-foot) hover to provide video surveillance of the north entrance to the bunker.

NROWS weapon module (top center) on the MDARS Exterior prototype.

Based on the helicopter imagery, MOCU next commanded the Urban Robot (URBOT) to approach the north entrance. Once the URBOT was in position, the helicopter relocated to cover the south entrance, while MDARS-E guarded the east entrance on Woodward Road. Upon seeing the helicopter, one intruder bolted from the south door and headed east. When this intruder crossed Woodward Road, MDARS successfully engaged with the Networked Remotely Operated Weapon System (NROWS).

The visitors were then relocated to Battery Woodward to observe the ability to autonomously search and map the interior of the underground bunker in which the remaining intruder was hiding. Serving as a surrogate for the URBOT, an All Terrain Robotic Vehicle (ATRV) was sent via MOCU to the bunker using the same GPS waypoint navigation employed on the URBOT, USV, and UAV. The ATRV then seamlessly transitioned to SLAM navigation and entered the north door to autonomously map and search the interior of the bunker, finding a .50-calibre machine gun and the second intruder hiding inside. The ATRV uploaded to the operator a virtual world model of the bunker, fused with tags and real-time visual snapshots marking the locations of both the weapon and intruder.

The attendees were next transported to the north end of the test site for two additional demos. The first was a robotic countermine operation conducted by the Idaho National Laboratory. Several of the autonomous functionalities optimized under the Technology Transfer Program have been incorporated into the Autonomous Robotic Countermine Experiment to fulfill the U.S. Army Engineer School's requirement to enhance IED detection and countermine capabilities. Specifically, the same autonomous behaviors seen on the ATRV were ported to Carnegie Mellon University's (CMU) countermine robot, which searched, detected, recorded in a map, and marked on the ground the location of buried landmines.

Estrellina Pacis (right) briefs the Technology Transfer Program prior to sending the autonomous ATRV into the bunker.

Bart Everett (far right) outlines SSC-SD's 25 years of research and development in robotics to Mark Asselin (far left), Cliff Hudson (fourth from left), Robert Wade (center) and Raleigh Durham (third from right).

The autonomous mine detection and marking system developed by INL, CMU and SSC San Diego

Code 2644 next demonstrated the iRobot R-Gator, which is being used for the Unmanned Vehicles for Physical Security pilot project, investigating current Unmanned Vehicle technologies for use in anti-terrorism force-protection scenarios. The intent is to perform unmanned perimeter reconnaissance with minimal user intervention at various naval sites for Commander, Naval Installations (CNI). Plans are to use MOCU to provide the command and control functionality for the North Island pilot installation.♦

Hugh Montgomery (left) gets a first-hand feel for the autonomous operation of the iRobot R-Gator on perimeter patrol.

ROBOTICS UPDATE
is published quarterly by:

SPAWAR Systems Center
San Diego, Code 2371
Unmanned Systems Branch

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